IV-10-1 Introduction

The development of a project requires the completion of a number of steps and a variety of coordination efforts. The consideration of environmental elements and regulations is an important component of the project development process. The analysis of environmental considerations needs to occur concurrently with the design of the project, to allow suitable study of impacts and the opportunity for design modifications, if it is determined that the impacts are undesirable.

The environmental context of a project (e.g., any natural and cultural resources that may exist or are planned in the area) and any potential impacts of the project on those resources, are important considerations in the transportation planning and design process. The passage of the National Environmental Policy Act (NEPA) and State Environmental Policy Act (SEPA) in 1970 and 1971, respectively, directs agencies to analyze and quantify the potential impacts of an action on the environment.

Most transportation agencies (including WSDOT) use a decision-making process that requires consideration of the environmental resources that may be impacted by a proposed project and require that certain types of environmental impacts be "mitigated". "Mitigation" involves a step-wise analysis of preferred responses to potential impacts, including: a) avoiding the impact altogether by not taking a certain action or parts of an action; b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; c) rectifying the impact by repairing, rehabilitating, restoring the affected environment; d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and, finally, e) compensating for the impact by replacing or providing substitute resources or environments.

Such consideration usually involves an analysis of any impacts to various "elements" of the "natural" and "built" environment identified in guidance documents for implementing NEPA and SEPA, but early and close cooperation with any agencies having jurisdiction (and any other interest groups) is the best way to identify the important environmental resources within an area and any potential mitigation for impacts to those resources.

The following sections provide some detail on the more common environmental considerations associated with transportation projects. The sections provide background information on the particular issue and some of the considerations a project team needs to incorporate into their decision-making process. It is important to note, that the following sections are only a few of the many environmental considerations that might potentially require evaluation as part of the development of a particular project. WSDOT's *Design Manual* and *Environmental Procedures Manual* provide a more complete look at NEPA, SEPA and the multitude of environmental considerations – what the issues are, the regulations associated with each consideration, and the process for securing approval and for compliance.

IV-10-2 Night Sky Darkness

IV-10-2-1 Introduction

The illumination systems associated with transportation facilities, have the potential to affect the surrounding environment – particularly in urban areas. Street lighting and other lighting, such as pedestrian crossing lights, have the potential to disturb the nocturnal environment. Night lighting can cause visual discomfort from direct glare, increased urban sky glow, light trespass into property where darkness is preferred, interfere with wildlife, impact vegetation, and waste energy if its an inefficient system. Special considerations might even need to be made to projects within historic districts.

IV-10-2-2 Governing Regulations and Directional Documents

There are currently few regulations on lighting and light pollution. However, a number of local jurisdictions, including the cities of Seattle, Bainbridge Island, Bothell, Redmond, Kent, Enumclaw, Pullman, Goldendale, Kelso, and Douglas and Island Counties have approved ordinances and codes regarding lighting within their jurisdictions. Most of the ordinances focus on shielding light from the unintended target and preventing glare from occurring.

During the design of urban projects, local regulations need to be reviewed to determine whether or not rules/ordinances have been developed on light pollution and light trespass and, if so, whether the project's lighting attributes follow the intent of existing local ordinances and codes.

IV-10-2-3 Definitions

light trespass – Occurs when light from another source is introduced to an area where light is unwanted – for example, when a neighbor's backyard floodlight illuminates a neighboring house.

light pollution – The uneconomical use of light that sends light wastefully towards the sky, or light that provides so much glare that a person cannot see anything else.

Figure IV-10.1 – Light Pollution

(Source:)

IV-10-2-4 Balancing Considerations

When illumination is called for in a project, there is an opportunity to ensure environmental impacts are minimized or avoided altogether. A well-designed illumination system reduces impacts by directing light, to the intended area and preventing direct glare. Examples of lighting systems that result in greater impacts to the environment are poorly aimed lights; ball lights or globe lights, no shielding; non-directional lights; and lights pointed towards the sky. Consider reflecting or shielding light away from adjacent properties and wildlife areas, in order to avoid or reduce potential impacts.

IV-10-2-5 Additional Resources

Environmental Services Office (ESO), Region Environmental Manager, WSDOT.

Archaeology and Historic Preservation Office, Washington State Department of Community, Trade and Economic Development, http://www.oahp.wa.gov/

IV-10-3 Air Quality

IV-10-3-1 Introduction

Air pollution originates from many different sources; including industries, small business, residential heating systems, and vehicular traffic. Air pollution can create human health issues, such as burning sensations in the eyes and nose, an itchy throat, and a difficulty with breathing. Air pollution has a greater effect on the young and elderly. Some contaminants permanently damage the lungs and may cause cancer. Besides effects on humans, air pollution can impact plants, animals, and property. Carbon dioxide emitted by motor vehicles has also been blamed as a major contributor to global warming.

Pollution control measures over the past 20 years have dramatically reduced pollutant emissions from vehicles; however, during that time, total vehicle miles traveled have doubled and traffic congestion has increased, resulting in overall higher levels of pollutants in some areas.

IV-10-3-2 Governing Regulations and Directional Documents

Under the Clean Air Act, the Environmental Protection Agency (EPA) sets limits on how much pollutant is allowed in the air, throughout the United States. Currently there are six criteria pollutants established as National Air Ambient Quality Standards intended to protect public health: carbon monoxide (CO); lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), and particulate matter (PM). The standard most likely to be exceeded in transportation is carbon monoxide.

Present laws require air quality analysis for all projects that change the flow of traffic[1] within or affecting air quality problem[2] areas for carbon monoxide. Projects that affect a problem area require the completion of a hot-spot analysis to predict future air quality. Special modeling software is used to quantify future pollutant emissions. In order for transportation projects to obtain federal funding, they are required to conform to the State Implementation Plan (SIP). Project conformity to the SIP is completed within the Transportation Improvement Program (TIP), which in turn, is prepared by the Metropolitan Planning Organization (MPO). Only those projects and alternatives included within TIP, can proceed to the construction phase.

IV-10-3-3 Definitions

carbon monoxide A by-product of the burning of fuels in motor vehicle engines. Motor vehicles are the main source of carbon monoxide, the excess of which is generally a problem during still, cold conditions.

[1] Changing flow of traffic includes such activities as signalization, intersection channelization, and added lanes.

[2] Air Quality problem areas are federally designated as non-attainment or maintenance areas by the Environmental Protection Agency. These areas include the Puget Sound Area, Vancouver, and Spokane.

conformity Projects are in conformity when they do not 1) cause or contribute to new violations of regulations in the area; 2) increase the frequency or severity of existing violations of regulations in the area, or 3) delay timely attainment of regulations, required interim emission reductions, or other milestones in the area.

maintenance area An area which previously was considered a "non-attainment area" but has since achieved compliance with the National Ambient Air Quality Standards (NAAQS).

non-attainment area An area that exceeds health-based NAAQS for certain air pollutants designated by the EPA.

State Implementation Plan (SIP) Each state must develop a SIP to explain how it will do its job under the Clean Air Act. A SIP is a collection of the plans a state will use to clean up polluted areas. The EPA approves the SIP.[3]

IV-10-3-4 Balancing Considerations

Air quality laws and regulations require that many types of projects be reviewed for potential impacts to air quality as part of the National Environmental Policy Act (NEPA) and State Environmental Policy Act (SEPA) evaluations. There are specific federal and state requirements within non-attainment and maintenance areas that require project designs to account for impacts to air quality. These regulations require air quality analysis, called "hot-spot" analysis, for projects that change the flow of traffic within the area or affect existing air quality problem areas by carbon monoxide. A hot-spot analysis predicts emission levels around the proposed project location, through the use of special modeling software.

Design elements that affect air pollution emissions and that subsequently need identification for modeling, include: roadway alignment, travel lane widths, traffic volumes, traffic speeds, turn lanes, traffic signals, signal cycle length, signal red time, signal green time, arrival times, and saturated flow rate. Locations near the projects that are accessible to the general public such as sidewalks, residences, parks, playgrounds and vacant lots also need to be identified.

Modeled projects that indicate an impact to air quality need to evaluate design modifications, in order to reduce the potential impacts. Project modifications need to change the project in a manner that improves air quality, in order to meet the NAAQS. Typical project modifications might be to adjust the roadway design to improve traffic flow, signal timing or placement, signal synchronization, addition of turn pockets, and/or consideration of roundabouts. The objective is to reduce the air quality impact to a level at or below the no-build scenario.

Project stakeholders might wish to consider opportunities for reducing the overall pollutants in the area. These considerations might not affect the level of pollutants that are modeled in a hot-spot analysis, but they can improve regional air quality. Project stakeholders can attempt to decrease regional air emissions by encouraging multi-modal transportation options,

[3] Environmental Procedures Manual, WSDOT, 2003

such as pedestrian, bicycle and transit use. Project modifications to encourage multi-modal transportation options might include wider sidewalks, adequate pedestrian crossings, slowing vehicle speeds, the addition of bicycle lanes, pedestrian rest areas, and transit pullouts. The incorporation of vegetation into the project can also improve air quality.

Particularly in the urban environment, the incorporation of the above elements can result in the loss of on-street parking, increased costs of right of way acquisition, and potentially displace existing businesses. A balance needs to be struck between air quality friendly design changes and the costs that are associated with them.

IV-10-3-5 Additional Resources

Air Quality, Acoustics and Energy, Environmental Services Office (ESO), Northwest Region, WSDOT, http://www.wsdot.wa.gov/regions/Northwest/rp&s/environmental/aae/default.htm

Air Quality Program, Washington State Department of Ecology, http://www.ecy.wa.gov/programs/air/airhome.html

Environmental Services Office (ESO), Region Environmental Manager, WSDOT.

IV-10-4 Noise and Vibration

IV-10-4-1 Introduction

Traffic noise is the sound generated on streets and highways. Noise has been of increasing concern to the general public and to local, state, and federal officials. At the same time, modern acoustical technology has been providing better ways to lessen the adverse impacts of traffic noise and state and local regulations have been established to restrict roadway construction noise during the evening and nighttime hours.

Vibration in urban areas, from vehicle traffic, rail transportation, and project construction, also has the potential to annoy and disturb people and animals. Vibration can even cause property damage. Affects from vibration vary according to the displacement, velocity, or acceleration that is generated. Heavy trucks and buses generate the highest levels of vibration on roadways.

IV-10-4-2 Design Purpose and Need

Noise

Sound levels from traffic noise depend on three things: (1) the volume of traffic, (2) the speed of the traffic, and (3) the number of trucks in the flow of traffic. Generally, heavier traffic volumes, higher speeds, and greater numbers of trucks increase the loudness of traffic noise. Vehicle noise is a combination of the noises produced by the engine, exhaust, and rolling tires in contact with the roadway. Conditions (such as a steep incline) that cause heavy laboring of motor vehicle engines will also increase traffic noise levels. There are other factors that affect the loudness of traffic. For example, as a person moves away from a highway, traffic noise levels

might be reduced, as a result of distance, terrain, vegetation, and natural and manmade obstacles.

Noise barriers are considered when noise impacts have been identified. Title 23 CFR 772 defines noise impacts as "impacts which occur when the predicted traffic noise levels approach or exceed the Noise Abatement Criteria (NAC), or when the predicted traffic noise levels (design year) substantially exceed the existing noise levels." WSDOT considers a predicted noise level of 1 decibel above the NAC as sufficient to satisfy the condition of approach. Locations impacted by traffic noise are to be considered for traffic noise abatement. Where abatement is warranted, at a minimum, the following types of abatement are to be considered:

- Traffic management measures (e.g., traffic control devices and signing for prohibition of certain vehicle types, time-use restrictions for certain vehicle types, and modified speed limits)
- Change of either vertical or horizontal alignment
- Construction of noise barriers
- Acquisition of property

The relevant criteria to consider when identifying and evaluating noise abatement measures are whether they are feasible and reasonable. Feasibility deals primarily with engineering considerations such as: can a substantial reduction be made or will abatement measures affect property access? Reasonableness assesses the practicality of the abatement measure, given a number of factors including: cost, amount of noise reduction, and future absolute traffic noise levels.

There are modified methods for dealing with transit-oriented noise for projects outside of the highway system (such as park and ride lots). The Federal Transit Administration (FTA) determines these methods and the applicability of the methods are evaluated on a case-by-case basis by the WSDOT.

Vibration

Within the Code of Federal Regulations (CFR), specifically 23 CFR 771.135, there are regulations pertaining to vibration on Section 4(f) facilities[4]. Elements that produce substantial vibration, like railroads, will need to focus concerns on long-term affects to 4(f) facilities. Temporary vibrations from construction activities to 4(f) facilities also need to be considered.

IV-10-4-3 Balancing Considerations

Noise

Urban areas may pose design challenges when considering noise abatement. These areas possess more access points for vehicles to enter and exit the

[4] 4(f) facilities include but may not be limited to public parks, recreation areas, wildlife/waterfowl refuges, historic sites, historic bridges and highways, archaeological resources, fairgrounds, school playgrounds, trails, wild & scenic rivers, public multi-use land holdings, bikeways, and scenic byways.

roadway - access that can either be restricted by an abatement measure or might require the incorporation of breaks into the abatement measure. Breaks in the abatement measure, such as a noise wall, might reduce the effectiveness and cause the abatement to be unfeasible. Adjoining roadways also contribute to the sound level of the area and might make a reduction in sound unfeasible. Noise walls or other abatement measures can create shadows on adjacent homes or even on the roadways, resulting in potential safety considerations. Abatement can also impact views from the roadway to commercial businesses or from adjacent properties to scenic views.

In a noise barrier project, project development staff might encounter a number of trade-offs among stakeholders. Concessions might be necessary in order to determine and agree upon an appropriate noise barrier location, and impacts to pedestrian access, parking, aesthetics, vehicle access, and other environmental considerations.

Figure IV-10.2 – Noise Wall

(Source:)

Noise barriers prevent and restrict access. Barriers can discourage pedestrian use, when a sidewalk is moved closer to traffic or is reduced in width in order to accommodate the installation of a noise barrier. On the other hand, noise barriers have the potential to improve safety by separating pedestrians and traffic (although this can also reduce feelings of public security, with the loss of visibility). A barrier might prevent parking along the roadway and prevent access to businesses or homes. A barrier might also encroach into a sensitive area, creating additional environmental impacts.

Once abatement has been determined necessary and feasible, project stakeholders need to consider abatement aesthetics. Consideration of opportunities for facial treatments and aesthetic appearance alterations can be included in the decision-making process.

Vibration

Project development staff need to consider impacts caused by vibration. A project team needs to work with local jurisdictions to identify locations where potential impacts might occur. Vibratory rollers, pile driving, and pavement or structure demolition are some construction activities that have the potential to cause property damage and interfere with local businesses. Vibration has the potential to structurally damage historic buildings and disrupt wildlife.

Project development staff also need to look for electronic laboratories, television stations, radio stations, and other calibration-type businesses near a proposed project. These types of businesses use sensitive equipment that can be harmed with vibration. Large-scale vibratory work near cemeteries might also cause a general concern among the public. Mitigation might be necessary in order to prevent or reduce impacts. Mitigation efforts might include a scheduling of the work outside of offices hours, down sizing the type of equipment used, or the use of different types of construction methods.

IV-10-4-4 Governing Regulations and Directional Documents

Environmental Impact and Related Procedures - Section 4(f) (49 U.S.C. 303), 23 CFR 771.135.

National Highway System Designation Act of 1995, Title 23 U.S.C..

Noise Barriers, *Standard Plans* D-2a – D-2t, WSDOT, M 21-01. http://www.wsdot.wa.gov/eesc/design/designstandards

Noise Evaluation Procedures for Existing State Highways, WSDOT, D 22-22.

Procedures for Abatement of Highway Traffic Noise and Construction Noise, Title 23 CFR 772.

Federal Highway Administration Report "Measurement of Highway-Related Noise." May 1996.

Federal Highway Administration Report Number FHWA RD-76-58, "Noise Barrier Design Handbook." February 1976.

Federal Highway Administration Report, "FHWA Highway Traffic Noise Prediction Model", FHWA-RD-77-108.

Federal Highway Administration Special Report, "Highway Construction Noise: Measurement, Prediction and Mitigation." May 2, 1977.

Federal Highway Administration Technical Advisory T6160.2, "Analysis of Highway Construction Noise." March 13, 1984.

FHWA directive "Highway Traffic Noise Analysis and Abatement: Policy and Guidance", June 1995. (Appendix D)

IV-10-4-5 Additional Resources

Fundamentals and Abatement of Highway Traffic Noise, FHWA, Washington, D.C., September 1980.

Highway Traffic Noise Analysis and Abatement Policy and Guidance, Federal Highway Administration (FHWA), Washington, D.C., June 1995.

Highway Traffic Noise in the United States: Problem and Response, Federal Highway Administration (FHWA), Washington, D.C., April 2000.

Air Quality, Acoustics and Energy, Environmental Services Office (ESO), Northwest Region, WSDOT, http://www.wsdot.wa.gov/regions/Northwest/rp&s/environmental/aae/default.htm

Environmental Services Office (ESO), Region Environmental Manager, WSDOT.

Noise Barrier Cost Reduction, Procedure STAMINA 2.0\OPTIMA: User's Manual, Federal Highway Administration Report Number FHWA-DP-58-1, National Technical Information Service [distributor] Springfield, Va., March 1982.

IV-10-5 Use of Recycled Materials

IV-10-5-1 Introduction

Many recycled products have uses in roadway construction and maintenance. Examples of uses include recycled asphalt pavement (RAP), concrete fly ash (primarily from coal-fired operations) and plastics. In many cases, the use of recycled material is cost competitive with the use of virgin material. Use of such material may save energy, reduces air and water pollution, and save valuable landfill space. Figure IV-10.3 lists examples of recycled products, their sources, and some applications of the products.

Figure IV-10.3 – Recycled Materials

Recycled Material	Sources	Uses
RAP	Roads, parking lots	Mixed w/ new asphalt for road and other pavement courses, road ballast, aggregate
Concrete	Concrete demolition	Aggregate, road ballast, asphalt aggregate
Fly Ash	By-product of coal combustion	Concrete additive, controlled density fill
Used Tires	Municipal Solid Waste (MSW)	Crumb rubber (chip and crack seal, some safety devices) embankment
Glass	MSW	Ballast, base, backfill, foundation material
Plastics	MSW	Posts, blockouts, noise wall.
Wood Wastes/Compost	MSW, roadside maintenance	Mulch for landscaping, amended loam

Figure IV-10.3 is not exhaustive. There are scores of innovative uses for recycled materials in road construction and maintenance. However, the listed materials and uses have been well studied.

While the use of recycled materials may have environmental and cost advantages, those materials must meet minimum performance criteria. A significant body of research exists concerning the use of recycled materials in highway construction and maintenance. Reference to a portion of that research is listed below.

IV-10-5-2 Definitions

recycled asphalt pavement (RAP) – Recycled asphalt pavement is asphalt pavement, either removed from the job site or stockpiled for use as a new asphalt pavement course or aggregate.

fly ash – Fly ash is very fine ash created by coal-fired combustion units, carried in flu gas and removed by air pollution control equipment.

municipal solid waste – Municipal solid waste includes household, commercial and industrial waste.

crumb rubber – Crumb rubber is small rubber pellets generated from the grinding and processing of used tires.

IV-10-5-3 Design Purpose and Need

The inclusion of recycled materials in a highway construction project is intended have three major outcomes. First, use of recycled materials will lessen the impacts of the project on natural resources by substituting recycled material for the use of virgin materials. Second, the use of recycled materials lessens impacts to air, water, and landfill space by avoiding the use, processing, and transportation of virgin materials and the subsequent pollution those processes cause. Third, the use of recycled materials can reduce the cost of the project, in situations where the use of recycled materials is cheaper than virgin materials. Consider the use of recycled materials when a supply is readily available, the material's costs are competitive with virgin materials, and/or when shipping of virgin materials can be reduced by substitution with recycled materials.

IV-10-5-4 Balancing Considerations

Under the right circumstances, the use of recycled materials in highway construction and maintenance reduces overall environmental impact of the activity, provides a market for those materials, reduces costs, and has the potential to increase a community's pride in the final product.

Cost and performance of any construction material, whether virgin or recycled, are critical considerations.

Cost

The cost of a material is a reflection of the market for the material and its constituents. For example, in times of high crude oil prices, RAP may enjoy a price advantage over virgin asphalt. The opposite may be true in times of low crude oil prices. Further, not all contractors are going to maintain large stockpiles of RAP or have access to other recycled materials at any given time. Therefore, great care needs to be given when requiring the use of recycled materials in any given design or contract.

Under certain circumstances significant environmental and cost benefits can be realized from the use of recycled materials. However, those circumstances are not always present. For example, circumstances advantageous to the use of recycled material include periods and locations where virgin materials are expensive or scarce, and when the source of recycled material is particularly plentiful (such as when the project, or a near by project, calls for significant asphalt or concrete demolition, or when the project is located near an area with an aggressive glass recycling program).

Performance

All building materials must meet basic performance requirements. Premature failure is not only unacceptable from a cost perspective, it is environmentally damaging, particularly if a project must be fixed or completely re-done with new materials. Consequently, it is vitally important that all materials meet the requirements outlined in the WSDOT *Standard Specifications*.

Test methods are both material and application specific. Required test methods can be found both in the *Standard Specifications* and the WSDOT *Materials Manual*.

IV-10-5-5 Governing Regulations and Directional Documents

Environmental Policy Statement, WSDOT, E 1018.00.

Materials Manual, WSDOT, M 46-01.

Standard Specifications for Road, Bridge and Municipal Construction, WSDOT, M 41-10.

Washington's Transportation Plan: 2003-2022, Goal 17, Washington State Transportation Commission and WSDOT, Olympia, WA, 2002. http://www.wsdot.wa.gov/ppsc/planning/

IV-10-5-6 Additional Resources

Use of Recycled Materials in Highway Construction, Federal Highways Administration (FHWA), http://iti.acns.nwu.edu/clear/infr/pr_ad94.html

Construction Office, Region Construction Engineer, WSDOT.

Environmental Services Office (ESO), Region Environmental Manager, WSDOT.

Materials Laboratory, Region Materials Engineer, WSDOT.

Investigation Into Organic Scrap Material Substitutions in Portland Cement Concrete, Research Report #1349-1F, University of Texas at Austin, Dept. of Civil Engineering, Center for Transportation Research, http://www.utexas.edu/depts/ctr/recycle/concrete.htm

Location and Availability of Waste and Recycled Materials in Texas and Evaluation of Their Utilization Potential in Roadbase, TxDOT Research Study 0-1348, Center for Transportation Research, http://www.utexas.edu/research/ctr/recycle/roadbase

Production Variability Analysis of Hot-Mixed Asphalt Concrete Containing Reclaimed Asphalt Pavement, Research Report #2918-1F, University of Texas at Austin, Dept. of Civil Engineering, Center for Transportation Research, http://www.utexas.edu/research/ctr/recycle/hmac.html

Recycled Materials In Embankments Except Glass, Study 0-1351, Center for Innovative Grouting Materials and Technology, University of Houston, http://www.utexas.edu/research/ctr/recycle/embank

Recycled Materials in Roadway Safety Devices, Research Report #1458-1, Texas A&M University System, College of Engineering, Texas Transportation Institute, http://www.utexas.edu/research/ctr/recycle/safety

Recycled Materials in Vertical Moisture Barriers, Research Report #1354, Texas Tech University, Dept. of Civil Engineering & Dept. of Chemical Engineering and University of Texas at El Paso, Dept. of

Civil Engineering,
http://www.utexas.edu/research/ctr/recycle/vertical.html

Use of Glass Cullet in Roadway Construction, Research Report #1331-1
Texas Tech University, College of Engineering,
http://www.utexas.edu/research/ctr/recycle/cullet

Using Hydrated Fly Ash as a Flexible Base, Research Report #1365-1F,
Texas Tech University, Dept. of Civil Engineering,
http://www.utexas.edu/research/ctr/recycle/flyash/html

IV-10-6 Green Streets

IV-10-6-1 Introduction

"Green Streets" is a concept that integrates the concepts of urban forestry and Low Impact Development (LID into the urban and semi-urban environments.

Low Impact Development is an innovative ecosystem based approach to land development and stormwater management that can supplement conventional stormwater treatment techniques and reduce site runoff. "Green Streets," an alternative term used for the same philosophy and set of techniques, seeks to manage stormwater and to make the best use of a street tree canopy, in order to intercept stormwater, mitigate for increased temperatures, and to improve air quality.

LID uses best management practices to handle the impacts of a roadway as near to the source of the impact as practical. LID best management practices (BMPs), use small-scale stormwater treatment techniques that are distributed evenly through a project area, in order to maintain or return the site run-off rate to pre-disturbance conditions. An example in a semi-urban area is the use of permeable concrete pavement systems for sidewalks in conjunction with smaller, linear stormwater detention facilities.

IV-10-6-2 Definitions

Green Streets – is a concept that integrates the concepts of urban forestry and Low Impact Development (LID into the urban and semi-urban environments.

Low Impact Development (LID) – is the ecosystem-based approach to land development and stormwater management that can supplement conventional stormwater treatment techniques and reduce site runoff.

urban forest – is the aggregate of all vegetation within an urban area, the management of populations of trees, and the interaction of people with the biology of urban flora and fauna.[5]

IV-10-6-3 Purpose and Need

Environmental regulation and best management practices requires treating and slowing the flow of stormwater after it runs off impervious road surfaces and before it reaches larger water bodies. The construction of large stormwater ponds requires large areas and is costly. Smaller, more evenly

[5] http://treelink.vservers.com/linx/?navSubCatRef=41

distributed, and linked bioretention depressions and swales can often handle the same quantity of runoff more efficiently at a lower cost than large-scale systems.

Trees provide shade, visually reduce the impact of large pavement areas, and reduce heat gain. They provide oxygen and trap particulates in the air, providing air quality improvements. In addition, they store water, providing stormwater storage capacity. These all have quantifiable benefits for the environment. Many cities and towns have permit requirements for street trees and planting islands.

Figure IV-10.4 – Bioretention

(Source:)

IV-10-6-4 Balancing Considerations

The need for handling stormwater, both for water quality treatment and for storage and infiltration has become increasingly important. In addition, cities view roadsides as a existing or potential location for urban forests, and as a place that conveys information about their community or area. There are many competing uses for our roadsides and the land available for these uses is often very expensive and in limited supply. There is increasing emphasis to look at the roadside as a resource in which multiple functions can be accommodated. In many cases, the roadside *can* perform many visual, operational, and environmental functions. In other cases, needs must be analyzed and prioritized. What functions can be accomplished within the median? Where might we be able to retrofit existing roadsides for new uses? An example is stormwater treatment. In the past, large ponds were constructed to retain and detain water from a large catchment area. Increasingly, we are moving toward treatment as close to the source of runoff as possible using multiple, smaller treatment facilities often referred to as Low Impact Development BMPs.

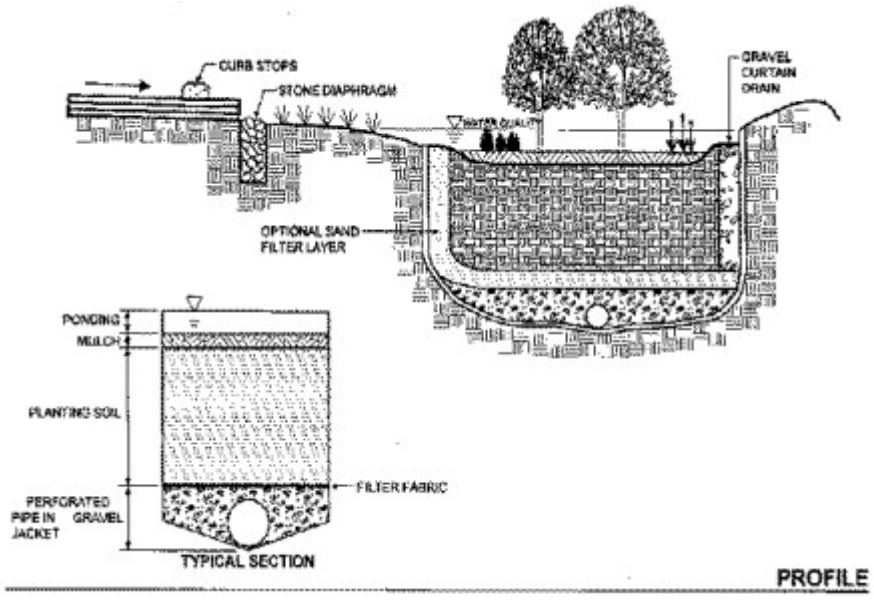
Low Impact Development

The following BMP's are examples of LID techniques that can be incorporated into a highway system.

- Engineered subsurface materials and underdrain systems allow swales to store and infiltrate water at a greater rate than conventional drainage ditches.
- On new projects, the retention of existing desirable vegetation where feasible, allows plant material to continue to intercept rainfall, to continue to provide air quality improvements, and to continue to mitigate surface temperatures.
- Linear compost filter strips and compost blankets adjacent to the roadway shoulder require little room, but are able to store and clean large amounts of stormwater runoff.
- Porous concrete pavements can be used for pedestrian surfaces and outlying parking areas. When properly constructed over an engineered subgrade, these systems can infiltrate 3 to 5 gallons

per minute per square foot. Many municipalities do not require any further stormwater mitigation measures when permeable pavements are used.

Figure IV-10.5 – Bioretention Area Cross Section



(Source:)

Figure IV-10.6 – Points to Consider for Low Impact Development Techniques

Points to Consider	
Retain existing vegetation where feasible	✓ Stormwater credit possible ✓ Design around significant vegetation ✓ Retaining walls may be needed
Remove existing vegetation	✓ Increased erosion ✓ Restoration necessary ✓ Stormwater runoff increases by quantity of water previously held in tree mass ✓ Mitigation for stormwater impacts increases ✓ Fewer constraints on design

Large, regional stormwater ponds	✓ Purchase large site for pond ✓ Excavate and haul material ✓ Revegetation necessary ✓ Fencing may be necessary if greater than 3H:1V side slopes
Large stormwater vaults	✓ Excavate and haul material ✓ Expensive, engineered system ✓ Fit under roadway? ✓ Expensive, on-going hazardous maintenance required
Multiple, small treatment sites close to source	✓ Fit into existing right of way ✓ Simple techniques ✓ Linked sites (string of pearls concept) each holding water ✓ Shallow slopes – no fencing
Compost filter strips or blankets	✓ Clean and detain water ✓ Can be blown on ✓ Enhance plant growth (which holds water) ✓ Cost for compost blown in place ✓ Erosion control BMP
Permeable Pavements	✓ Soils must drain but not too quickly ✓ Engineered subgrade to hold water before it infiltrates ✓ Infiltrates 3 to 5 gallons per minute ✓ No stormwater mitigation needed for these surfaces – decreased cost ✓ Lifecycle same as conventional concrete ✓ Cost 25% more than conventional pavements ✓ Requires semiannual sweeping or power washing

Large initial investments in these techniques have to be evaluated in the context of savings realized by not having to construct large regional ponds or vault systems for stormwater mitigation.

The Washington State Department of Ecology's *Stormwater Manual* allows stormwater credits for the retention of trees on a site. A large, mature tree

can store up to 500 gallons of water in its infrastructure at any one time. Cutting that tree down necessitates allowing for the storage of that water in a pond. Therefore it might cost more to cut a large group of trees down than to preserve them.

Urban Forests

The images in Figure IV-10.7 show the same street. The one on the left is the existing condition. On the right, the image digitally altered to add street trees.

Figure IV-10.7
Existing Street[6]

Digitally enhanced photo of same street after 25 years

(Source: W&H Pacific, Beaverton, Oregon)

Urban forests improve air quality by reducing atmospheric carbon dioxide levels and absorbing air pollutants. Trees can directly sequester carbon dioxide as woody and foliar biomass while they grow. Properly planted and managed trees can also reduce the need for heating and air conditioning. A study of six million trees reveals that the trees remove and store approximately 304,000 tons of atmospheric carbon dioxide, 12,000 tons of ozone, and 9,000 tons of particulates.[7]

Another study shows that trees provide important benefits in parking lots by moderating the heat absorbed by asphalt. Cooler air temperatures reduce ozone concentrations by lowering hydrocarbon emissions. The cooler the car, the lower the rates of evaporation from gas tanks, hoses, and vehicle fabrics. Trees in Davis, California parking lots reduced surface asphalt temperatures by as much as 36°F, vehicle cabin temperatures by over 47°F, and fuel-tank temperatures by nearly 7°F.

Street trees can play an important role in stormwater management and air quality matters. A study by Xiao, et al,[8] found that a 9-year-old broadleaf

[6] Both photos from W&H Pacific, Beaverton, Oregon, 1996.
[7] http://wcufre.ucdavis.edu/research/air.html
[8] Xiao, Quigfu, E. Gregory McPherson, Susan L. Ustin Mark E. Grismer and James R. Simpson. Winter rainfall interception by two mature open-growth trees in Davis, California. Hydrological Processes, 14, 763-784 (2000).

deciduous pear tree accounted for intercepting 15% of gross precipitation and an 8-year-old broadleaf evergreen tree (cork oak) captured 27%. The maximum amount of interception occurred at the beginning of each event. (Interception is defined as the sum of canopy surface water storage and evaporation.)

One study found that a medium-sized tree can intercept as much as 2380 gallons of rainfall per year. A mature evergreen tree (75 feet or more) in coastal regions is estimated to intercept 4,000 gallons of rainfall per year and at any given time sequester up to 200 gallons.[9] Computer simulations of deciduous trees in California's Central Valley estimate that for every 1000 trees, stormwater runoff is reduced nearly 1 million gallons - a value of almost $7000. These values are clear evidence of the role trees play in reducing runoff of polluted stormwater and in reducing the need for engineered controls.[10]

A study of urban forests in Modesto, California shows that for each $1 invested in urban forest management, $1.89 in benefits is returned to residents. City trees actually remove 154 tons of air pollutants, increase property values by over $1.5 million, and provide shade that saves over $1 million in energy costs.[11]

A pilot study has found that shade from street trees extends the life of asphalt concrete pavement.[12]

Studies show there are significant human benefits from urban forests and the experience of nature. Physiological responses to stress are mitigated: blood pressure lowers, breathing and heart rates slow, medical recovery rates and convalescence shorten with views of nature, and productivity increases. Studies at the University of Washington show consumers prefer shopping where there are street trees and groomed plants. In addition, the same study shows that consumers are willing to pay 12% more for the same product in a store along a tree-lined street. Street trees are good for business.[13]

Figure IV-10.8 – Points to Consider for Street Trees

Points to Consider	
Provide Street Trees	✓ Offsets and varying curb heights may be needed and are dependent upon design speed. See http://www.wsdot.wa.gov/eesc/design/Urban/PDF/NewBrochure.pdf and chapter 700 of the *Design Manual*
	✓ "Structural" soils advisable to provide for root growth under pavement. See region's Landscape Architect
	✓ Irrigation necessary

[9] United States Department of Agriculture - Forest Service. Web Home Page, September 2001
[10] http://wcufre.ucdavis.edu/research/water.html
[11] http://wcufre.ucdavis.edu/research/benefit.html
[12] http://cufr.ucdavis.edu/research/studies_detail.asp?projectid=50
[13] http://www.cfr.washington.edu/research.envmind/CPCityBiz.html

	✓ Enhanced sense of community
	✓ Increased property values
	✓ Shoppers prefer to shop at stores along tree-lined streets, and they are willing to spend 12% more for the same product at stores on tree-lined streets.
	✓ Stormwater uptake
	✓ Oxygen produced, carbon dioxide taken up
	✓ Shade & cooling in summer – energy use down
	✓ Air quality improvements
	✓ Annual maintenance required to sweep and dispose of leaves. Pruning required occasionally to keep the tree in a healthy condition.
	✓ If not chosen or planted properly, trees may lead to long-term problems of pavement heaving and cracking.

IV-10-6-5 Analysis Method

Low Impact Development

LID techniques can be used effectively in semi-urban and urban areas as well as in rural, open, or forested areas. Parking lots and sidewalks can be effectively retrofitted to use LID techniques to store and treat stormwater before releasing it to a sewer system. See the *Highway Runoff Manual* and the Parking Area Design chapter in the *Roadside Manual* for more detailed information.

While LID techniques might not handle all stormwater runoff on sites with high percentages of impervious surfaces, they can be used in combination with more conventional treatments to clean and detain stormwater runoff.

Urban Forests

Locating trees along a state highway requires compliance with clear zone requirements found in chapter 700 of the *Design Manual*. The selection of slow-growing trees with trunk diameters, at maturity, of less than 4 inches is a way to incorporate street trees and meet safety requirements at the same time.

Section 8 of the *Roadside Manual* and a local government's Urban Forester can provide guidance on plant selection and establishment.

When street trees are included in a design, provide them with adequate rooting room and a source of water and air. Street tree grates are a method of protecting the immediate rooting zone around the tree trunk. More growing room for tree roots is needed than is typically provided. The use of structural soils[14,15] beneath sidewalks and the use of permeable pavements

[14] http://www.hort.cornell.edu/department/faculty/bassuk/uhi/outreach/csc/article.html

are ways to provide tree roots with enough room to grow to support healthy tree growth.

Figure IV-10.9 – Street Trees in Downtown Pullman, Washington

(Source:)

In addition, it is important to use proper planting and construction techniques to safeguard the structural stability of sidewalks, curbing, and pavement, and to consider the sight distances that the mature tree may impact due to its placement.

IV-10-6-6 Governing Regulations and Directional Documents

Clean Air Act, 42 U.S.C. §§ 7401-7642.

Clean Water Act, 33 U.S.C. § 1344**.**

Design Manual, WSDOT, M 22-01.

Highway Runoff Manual, WSDOT, M 31-16.

Puget Sound Runoff Program, Washington Administrative Code (WAC) 173-270.

Puget Sound Water Quality Authority Act, Revised Code of Washington (RCW) 90.70.

Roadside Classification Plan, WSDOT, M 25-31.

Roadside Manual, WSDOT, M 25-30.

State Water Pollution Control Act, RCW 90.48.

[15] http://www.urban-forestry.com/citytrees/v36n3a12.html

Stormwater Management Manual for Western Washington, Washington Water Quality Program, State Department of Ecology, Olympia, WA, 2001. http://www.ecy.wa.gov/pubs/9915.pdf

Water Resources Act of 1971, RCW 90.54.

IV-10-6-7 Additional Resources

Center for Urban Forest Research, http://wcufre.ucdavis.edu/

Environmental Services Office (ESO), Region Environmental Manager, WSDOT.

Green Streets: Innovative Solutions for Stormwater and Stream Crossings Handbook, City of Portland, http://www.metro-region.org/article.cfm?ArticleID=262

Hydraulics Office, Headquarters Hydraulics Engineer, WSDOT.

Landscape Architecture Office, Region or Headquarters Landscape Architect, WSDOT.

Low Impact Development, Puget Sound Water Quality Action Team, http://www.psat.wa.gov/Programs/LID.htm

Stormwater Management Fact Sheet: Bioretention, The Stormwater Manager's Resource Center, http://www.stormwatercenter.net/Assorted%20Fact%20Sheets/Tool6_Stormwater_Practices/Filtering%20Practice/Bioretention.htm

IV-10-7 Cultural and Historic Resources

IV-10-7-1 Introduction

Cultural resources are important reflections of past cultural and environmental influences. Cultural resources are the remains of sites, structures or objects used by humans in the past. These resources can be historic, prehistoric, archaeological or architectural, in nature. Cultural resources vary and can assume very different forms - ranging from the remnants of artifacts, to structures, open areas, or groupings of resources that are similar in characteristics, such as historic districts. Cultural and historic resources provide an invaluable glimpse into the past and might be of significant importance to a community or Tribe's history and culture.

As such, the development of any project needs to appropriately consider cultural resources throughout the planning, design, and construction phases of a project, in order to ensure that these non-renewable, environmentally sensitive resources are protected, conserved and interpreted, where appropriate. Cultural resources are afforded the greatest potential for preservation, when project proponents actively engage interested consulting parties in the proposed activity; collaboratively identify resources; and cooperatively seek ways to avoid, minimize, or, if no other recourse is available, mitigate impacts to resources.

Adequate consideration to cultural resources and their intrinsic value can ensure that these resources' integrity is retained for future generations.

IV-10-7-2 Definitions

Advisory Council on Historic Preservation (ACHP) – is an independent federal agency, established under the National Historic Preservation Act (NHPA), that: 1) advises the President and Congress on matters of historic preservation; 2) conducts Section 106 reviews; and 3) provides technical assistance in historic preservation actions.

affect – An action that might change the character of a historic resource.

cultural landscape – A geographic area that has historically been used by people; or shaped or modified by human activity, occupancy, or intervention; and possesses a significant concentration, linkage or continuity of areas of land use, vegetation, buildings and structures, roads and waterways, and natural features.

cultural resource – Cultural resources are the remains of sites, structures, or objects used by humans in the past. They are visible evidence of human interaction with the environment. The term "Cultural Resources" refers to actual physical things, places, structures, or artifacts that are material evidence of a past way of life, as well as to traditional cultural properties. They can be historic, prehistoric, archaeological, or architectural in nature and may be grouped in districts.

historical properties – Cultural resources eligible for or listed in the National Register of Historic Places.

National Register of Historic Places – The nation's official listing of properties significant in national, state, and/or local history, meeting one or more criteria for evaluation, as outlined in 36 CFR 60.4.

Section 106 review – The Advisory Council's regulations (36 CFR 800), which implements Section 106 of the National Historic Preservation Act of 1966, as amended. This is the federal review process that ensures that historic properties are considered during federal aid project planning and execution.

undertaking – Any activity that can result in changes to the character or the use of historic properties. The activity is required to be under the direct or indirect jurisdiction of a federal agency.

A more extensive list of terms and definitions related to cultural resources can be found in WSDOT's *Environmental Procedures Manual* Exhibit 456-1.

IV-10-7-3 Design Purpose and Need

There are a number of federal, state and local requirements that dictate cultural resource preservation. The processes that are required are dependent on the project purpose and need, the available funding sources, and the requirements specified on the permits. Appropriate time and resources need to be devoted to the consideration of cultural resources during the project development process.

When developing a project, avoidance of known historic and cultural resources needs to be the first priority. In situations where avoidance is not feasible, the project development staff need to minimize the impacts and if

minimization efforts fail, they must mitigate the impacts. Development of mitigation requires active dialogue with the Washington State Office of Archaeology and Historic Preservation, Tribes, community members and other interested parties.

It is important to recognize that cultural resources provide invaluable reminders of the past and more importantly, can be of the utmost importance and significance to a community. The disregard of resources or the introduction of visual, audible, or atmospheric elements that are out of character with historic properties or settings can result in adverse effects to historic properties and communities.

Consideration of cultural resources is an important step in the overall project development process, in order to ensure resources are adequately protected.

IV-10-7-4 Balancing Considerations

The intent of considering cultural resources during the project development process is to ensure protection of those resources and afford adequate opportunity for meaningful consultation with interested parties.

The goal of consultation is to seek a mutual agreement regarding proposed actions and their potential effects on historic properties. Consultation can result in the avoidance of impacts to cultural resources; the minimization of effects; or mitigation measures. The resulting course of action needs to be a product of meaningful dialogue with all interested parties.

Meaningful dialogue can result in the opportunity for preservation of cultural resources and the development of a project in a manner that is consistent with an area's cultural and historic characteristics. It also has the potential to foster strong relationships with consulting parties. The dialogue can help to avoid the introduction of new elements that are out of character with existing resources or the surrounding area which can result in depreciation of the characteristics that define a resource's cultural or historic significance.

A common misperception is that urban areas do not have any cultural resources, due to the extensive level of disturbance. This is not the case, as many large metropolitan areas are rich with cultural resources in the form of historic districts and structures and prehistoric remains buried beneath modern developments.

Figure IV-10.10 – Cultural Resources

(Source:)

Another common misperception is to disregard the potential historical significance of a bridge or structure. Regardless of the extent of dilapidation or the need for replacement, a bridge or structure might be eligible for the National Register of Historic Places and need to be appropriately handled, prior to demolition or rehabilitation.

Lack of meaningful consultation with interested consulting parties has the potential to delay the project indefinitely; increase the costs of the project; and create mistrust between parties.

IV-10-7-5 Analysis Method

There are numerous federal, state and local laws that require an agency to consider their proposed project's impacts to cultural resources. Careful consideration of cultural resources and active, meaningful coordination with interested parties is essential for compliance with these requirements.

Federal Requirements

Section 106 of the National Historic Preservation Act requires federal agencies, and their delegates, to take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment on such undertakings. The Section 106 process seeks to balance historic preservation concerns with the need for a federal undertaking, through consultation among agency officials and other parties with an interest in the effects of the undertaking on historic properties. This consultation process needs to commence at the earliest planning stages of the project.

In addition to identifying interested consulting parties for the project, identification of cultural and historic resources is an important step in the Section 106 process. The National Historic Register criteria for eligibility are the defining guidelines for determining the presence of cultural and historic resources. The criteria evaluate the resource's value with respect to its significance in American history, architecture, archaeology, engineering, and culture. To be eligible or listed on the National Register, the historic property must meet one of four criteria: 1) the resource is associated with significant events from the past; 2) the resource is associated with a significant person from the past; 3) the resource embodies distinctive characteristics of a type, period, or method of construction; or 4) the resource has or can yield information that is significant to history.

The goal of consultation is to identify interested parties; identify historic properties potentially affected by the undertaking; make an assessment as to the effects the undertaking will have on the resource; and seek ways to avoid, minimize, or, if need be, mitigate any adverse affects to cultural resources.

Chapter 456 in WSDOT's *Environmental Procedures Manual* provides a more detailed explanation of the Section 106 review process and its individual steps and requirements.

State Requirements

The *State Environmental Policy Act* (SEPA) requires an agency consider the impacts of a proposed project to cultural resources during the public environmental review process.

Agencies proposing projects that lack a federal nexus, consult with the Washington State Office of Archaeology and Historic Preservation (OAHP) through the SEPA process. OAHP provides agencies with formal opinions on a project site or a resource's significance and the potential impacts to cultural and historic resources.

The Washington State's Department of Ecology SEPA and Office of Archaeology and Historic Preservation web pages,

http://www.ecy.wa.gov/programs/sea/sepa/e-review.html and http://www.oahp.wa.gov/envir.htm, respectively, provide additional detail on the process non-federal nexus projects must undergo.

Local Requirements

City and county comprehensive plans can contain a historic preservation element - a goal stated in the Growth Management Act (GMA). Consideration needs to be given to city and county comprehensive plans, as well as parks and recreation plans, that might contain policy and plan guidance on historic resources, sites, and/or structures of local importance.

In addition, local agencies might maintain their own inventories of historic sites that are of local significance.

IV-10-7-6 Governing Regulations and Directional Documents

Abandoned and Historic Cemeteries Act, Revised Code of Washington (RCW) 68.04-05.

Archaeological Resources Protection Act of 1979, Title 16 United States Code (U.S.C) § 470.

Department of Transportation Act of 1966 (Section 4f), 49 U.S.C. § 303.

Environmental Procedures Manual, WSDOT, M 31-11.

Environmental Procedures Manual Chapter 456.08-1, WSDOT, M 31-11.

Growth Management Act (GMA) RCW 36.70A.

Indian Graves and Records Act, RCW 27.44.

National Environmental Policy Act (NEPA), 42 U.S.C. §§ 4321-4370(f).

National Historic Preservation Act of 1966, as amended, 16 U.S.C. §§ 470(f), 106 (repealed December 16, 1930).

National Register of Historic Places - Criteria for Evaluation, 36 CFR 60.4.

National Register of Historic Places - Protection of Historic Properties, 36 CFR 800.

Native American Graves Protection and Repatriation Act (NAGPRA), 25 U.S.C. § 3001.

Protection of Archaeological Resources, Title 43 Code of Federal Regulations (CFR) Part 7.

State Environmental Policy Act (SEPA), RCW 43.21C, WAC 197-11, WAC 468-12.

Surface Transportation and Uniform Relocation Assistance Act, (STURAA) of 1987, Public Law 100-17.

IV-10-7-7 Additional Resources

Advisory Council on Historic Preservation, http://www.achp.gov/

Archaeology and Historic Preservation Office, Washington State Department of Community, Trade and Economic Development, http://www.oahp.wa.gov/

Environmental Services Office (ESO), Region Environmental Manager, WSDOT. http://www.wsdot.wa.gov/environment/culres/default.htm

National Register of Historic Places, http://www.cr.nps.gov/nr/index.htm

Washington State OAHP Historic Register, http://www.oahp.wa.gov/register/index.tpl

IV-10-8 Urban Streams

IV-10-8-1 Introduction

Historically, cities were commonly developed along waterways. Consequently, many of our urban areas have streams or rivers running through them. For many years the value of streams was not recognized - streams were routed through culverts, straightened, lined with rock, or filled with debris. With increased recognition of their environmental, psychological, and social benefits, many cities are day lighting and restoring their local waterways. Highways can have streams that either cross under the roadway or run parallel to it. For this reason, WSDOT has the opportunity to restore or enhance streams and their associated riparian buffers.

The listing of several salmonid species under the Endangered Species Act in recent years has added additional complexity to the already ecologically and philosophically complex issue of stream restoration and relocation. Due to unavoidable impacts, or in order to improve fish habitat and movement, WSDOT is often required to relocate streams. The WSDOT may also improve habitat as a component of environmental mitigation.

IV-10-8-2 Definitions

Large Woody Debris (LWD) – sometimes referred to as Coarse Woody Debris (CWD), are large pieces of wood in a stream or river that will not wash away easily.

riparian areas – A complex, interdependent system of plants and biota in an environment adjacent to water. Riparian areas intercept stormwater, remove pollutants, stabilize banks, offer a future supply of LWD, provide wildlife habitat, and moderate water temperatures.

riparian buffers – A management tool or practice for protecting riparian areas and their associated water bodies.

IV-10-8-3 Design Purpose and Need

Stormwater regulations require public agencies to treat stormwater for quantity and quality to a higher degree than was required in the past. This creates opportunities for innovative projects that treat stormwater before it enters streams and water bodies adjacent to the highways. Often more than one agency can partner in a project that results in benefits for all participants.

Innovative Stormwater Treatment Facilities & Stream Restoration

As an example, prior to construction of the Indian Creek Stormwater Treatment Facility, untreated storm water from Interstate 5 flowed into a natural tributary on this site, degrading both the tributary and Indian Creek. The site, considered to be of little value, was overgrown with invasive plant species and was used as a dumping ground.

Figure IV-10.11

(Source:)

Through a cooperative effort with the Washington State Department of Transportation, the City of Olympia, the Olympia Arts Commission and the Squaxin and Nisqually Tribes, this new facility serves as a tranquil escape in the midst of an urban environment, while providing an effective regional stormwater treatment facility. Indian Creek's unique bioengineered design integrates public art with functional aspects of stormwater treatment and slope stabilization. Berms were used to reduce noise pollution and to provide a gentle separation between the trails, highway, and surrounding neighborhood. The berms were planted with native plant species.

Figure IV-10.12

(Source:)

When streams cross under a new section of roadway or fish passage is improved, WSDOT has the opportunity to add complexity and restore the stream buffer. In-stream complexity can be accomplished by adding Large Woody Debris (LWD) or rock of varying sizes. Size and type of rock or LWD is dependent on the gradient, stream flow, contributing watershed, substrate, and habitat needs. Stream buffers are enhanced with native woody vegetation. A multidisciplinary team consisting of a hydrologist or fluvial geomorphologist, habitat biologist, landscape architect, and hydraulic engineer develop the stream restoration plan.

Figure IV-10.13

(Source:)

IV-10-8-4 Balancing Considerations

A restored urban stream and its associated riparian system can provide multiple benefits to a watershed, its wildlife, and its people. A successful project provides a stable channel within a dynamic equilibrium, provides

habitat for a target species, and provides a riparian ecosystem as a buffer and a source of future LWD recruitment. This can be achieved and still allow people to view the site at specific points so that wildlife use is not impaired.

Many urban streams are highly degraded systems that do not function for wildlife, desired stream dynamics and ground water recharge, or for people. An urban stream restoration is an opportunity for public education. The multiple functions of a healthy riparian system can be taught to citizens during the planning and permitting process as well as through signs at the site after the project is completed.

- Community acceptance of projects can grow with success
- Habitat improvement
- Desirable place for people to walk or view wildlife
- Increased stormwater treatment possibilities
- Educational opportunities
- Unlimited human access will discourage wildlife use and degrade the riparian buffer
- In urban areas, planting might need to be larger and denser to provide for faster plant establishment so people can see quick results and to prevent trampling of small plants
- Urban hydrology is more variable than natural stream systems
- Alternative stormwater treatment requires doing something different than a standard rectangular pond

IV-10-8-5 Analysis Method

The latest version of WSDOT's *Highway Runoff Manual* provides information on alternative stormwater treatment opportunities using Low Impact Development (LID) techniques.

WSDOT's *Environmental Procedures Manual* provides guidance on permitting requirements for stream restoration and stormwater treatment requirements.

WSDOT's *Roadside Classification Plan* and the *Roadside Manual* provide information on stream restoration and requirements for roadside restoration in urban and semi-urban environments.

IV-10-8-6 Governing Regulations and Directional Documents

Clean Water Act, 33 United States Code (USC) § 1344.

Construction Projects in State Waters, Revised Code of Washington (RCW) 77.55.

Endangered Species Act, *as amended*, 16 USC §§ 1531-1543.

Environmental Procedures Manual, WSDOT, M 31-11.

Highway Runoff Manual, WSDOT, M 31-16.

Highway-Related Stormwater Management, RCW 90.78.

Hydraulics Manual, WSDOT, M 23-03.

National Environmental Policy Act (NEPA), 42 U.S.C. §§ 4321-4370(f).

Roadside Manual – Soil Bioengineering Chapter, WSDOT, M 25-30.

Salmon Recovery, RCW 77.85.

Shoreline Management Act, RCW 90.58.

State Environmental Policy Act (SEPA), RCW 43.21C, WAC 197-11, WAC 468-12.

Water Pollution Control, RCW 90.48.

IV-10-8-7 Additional Resources

Harrelson, Cheryl C., C. L. Rawlins, and John P. Potyondy, *Stream Channel Reference Sites: An Illustrated Guide to Field Techniques,* USDA Forest Service, Fort Collins, CO, 1994. http://www.stream.fs.fed.us/publications/PDFs/RM245E.PDF

Abbe, T. B., "There Are About One Hundred and Twenty Trees and Several Thousand Tons of Wood in the ELJ; Will It Do What We Expect?" *Wildlife Conservation,* Vol. 4, 1999, pp. 46-51.

Abbe, T.B. and D.R.. Montgomery, "Large Woody Debris Jams, Channel Hydraulics and Habitat Formation in Large Rivers," *Regulated Rivers: Research & Management,* Vol. 12, no. 2-3, 1996, pp. 201-221.

Abbe, T.B., D.R. Montgomery, K. Fetherston, and E.M. McClure, "A Process-Based Classification of Woody Debris in a Fluvial Network: Preliminary Analysis of the Queets River, WA," EOS Transactions, *American Geophysical Union,* Vol. 74, 1993, p. 296.

A Guide to Placing Large Wood in Streams, Oregon Department of Forestry, and Oregon Department of Fish And Wildlife, 1995.

Leopold, Luna B., *Fluvial Processes in Geomorphology*. W.H. Freeman, San Francisco, 1964.

Leopold, Luna B., *A View of the River*, Harvard University Press, Cambridge, MA, 1994.

Maser, C. and J.R. Sedell, *From the Forest to the Sea: The Ecology of Wood in Streams, Rivers, Estuaries and Oceans*, St. Lucie Press, Delray Beach, Florida, 1994.

Montgomery, D.R., J.M. Buffington, R.D. Smith, K.M. Schmidt, and G. Pess, "Pool Spacing in Forest Channels," *Water Resources Research,* Vol. 31, no. 4, 1995, pp. 1097-1105.

Montgomery, D.R., T.B. Abbe, J.M. Buffington, N.P. Peterson, K.M. Schmidt, and J.D. Stock, "Distribution of Bedrock and Alluvial Channels in Forested Mountain Drainage Basins." *Nature*, Vol. 381, no. 6583, 1996, pp. 587-589.

Rosgen, David L., *Applied River Morphology*, Wildland Hydrology, Pagosa Springs, Co., 1996.

Rosgen, David L., "A Classification of Natural Rivers," *Catena*, Vol. 22, No. 3, 1994, pp. 169-199.

Sedell, J.R., G.H. Reeves, F.R. Hauer, J.A. Stanford, and J.H. Hawking, "Role of Refugia in Recovery From Disturbances: Modern Fragmented and Disconnected River Systems," *Environmental Management,* Vol. 14, 1990, pp. 711-724.

Stream Corridor Restoration, Federal Interagency Stream Corridor Restoration Working Group, Springfield, VA, revised 2001. http://www.usda.gov/stream_restoration/newtofc.htm

Stream Habitat Restoration Guidelines, Washington Department of Fish and Wildlife (WDFW), 2002, http://wdfw.wa.gov/habitat.htm - habrest

Wood in World Rivers International Conference, searchable database, http://riverwood.oregonstate.edu/html/intro.html

IV-10-9 Fish, Wildlife, and Plant Resources

IV-10-9-1 Introduction

WSDOT, as an Agency, is committed to preserving, protecting, and enhancing the state's environmental resources, including vegetation, fish, wildlife, and their habitats. This section provides a basic overview of a few of the environmental commitments that WSDOT has made. WSDOT's guidance on addressing the preservation and enhancement of natural resources is constantly being updated to reflect the best available science.

Wildlife, fish, and sensitive plants require special consideration during project planning and development. In addition to Endangered Species Act (ESA) compliance, areas of particular concern include: direct effects from construction such as noise disturbance or other disruption of habitat areas; interference to critical life functions such as wintering, foraging, migration, breeding and/or rearing; degradation or loss of habitat; habitat fragmentation and edge effects; effects related to collisions between vehicles and animals; loss of animal or plant populations or viability, and impacts to food resources.

IV-10-9-2 Definitions

endangered species – Any species, which is in danger of extinction throughout all or a significant portion of its range

federal nexus – When an action is authorized, funded, or carried out by a federal agency

habitat – Place where a plant or animal naturally or normally completes its life cycle

indirect effects – Effects caused by or resulting from the proposed action but that occur later in time, including effects resulting from associated development and other activities that occur following improvements in transportation

listed species – Any species of fish, wildlife, or plant, which has been determined to be endangered or threatened under Section 4 of the ESA

programmatic biological assessment – A biological assessment designed to cover programs, not specific projects

threatened species – Any species, which is likely to become endangered within the foreseeable future throughout all or a significant portion of its range

viability – Ability of a population to maintain sufficient size so it persists over time in spite of normal fluctuations in numbers; usually expressed as a probability of maintaining a specific population for a defined period

IV-10-9-3 Design Purpose and Need

WSDOT biologists are involved at all stages of construction design and project development, but coordination early in the process allows the identification of potential adverse impacts and the opportunity to establish avoidance or minimization measures.

Protection of the natural environment is an Agency-wide WSDOT commitment. The treatment of stormwater flows from new and existing impervious surface is necessary to prevent potential impacts to fish and wildlife. Design elements that treat both stormwater quality and quantity before it reaches aquatic environments provide the greatest amount of protection.

Urban natural areas are increasingly important for many species, including songbirds and small mammals. It is important to consider the preservation or replacement of these urban natural areas when projects are implemented.

Wildlife mobility is often overlooked when designing projects in urban environments. The ability for wildlife to move safely between different environments is important for both species preservation and public safety. Project design can influence both of these factors. Traffic-related wildlife mortality may play a role in the decline of some species listed under the Endangered Species Act.

Figure IV-10.14 – Wildlife Resources

(Source:)

IV-10-9-4 Balancing Considerations

The ESA requires projects with a federal nexus to address impacts to listed species. However, all projects that may potentially impact any fish, wildlife, or plant resource, regardless of federal nexus or listing status, should evaluate project design in order to reduce or eliminate impacts. Several design challenges may arise when the commitment to protect fish, wildlife and plant resources is made. Involving the Environmental Services' Biology Branch early in the design process can ensure that minimization or avoidance measures can be implemented.

IV-10-9-5 Governing Regulations and Directional Documents

Several policies and procedures are in place to ensure that WSDOT complies with environmental laws and regulations regarding the protection

of species. Several elements regarding the potential impacts to wildlife, fish, and plant species are addressed before a project can be completed. A few of the environmental laws and regulations that pertain to fish, wildlife, and plant resources include the following:

Bald and Golden Eagle Protection Act,16 U.S.C. § 668.

Endangered Species Act, 16 U.S.C §§ 1531-1544.

Fish and Wildlife Coordination Act, 16 U.S.C. §§ 661-667(e).

Local and Critical Areas Ordinances.

Magnuson-Stevens Act – to Address the Preservation of Essential Fish Habitat (EFH), 16 U.S.C. § 1801.

Marine Mammal Protection Act, 16 U.S.C. § 1361.

Migratory Bird Treaty Act, 16 U.S.C. § 703.

National Environmental Policy Act (NEPA), 42 U.S.C. §§ 4321-4370(f).

Shoreline Management Act, RCW 90.58.

State Environmental Policy Act (SEPA), RCW 43.21C, WAC 197-11, WAC 468-12.

IV-10-9-6 Additional Resources

Environmental Guidebook, Federal Highway Administration, http://environment.fhwa.dot.gov/guidebook/index.htm

National Marine Fisheries Service (NOAA Fisheries), Northwest Region, http://www.nwr.noaa.gov/

United States Fish and Wildlife Service, Pacific Region, http://pacific.fws.gov/

Biology Program, Environmental Services, WSDOT, http://www.wsdot.wa.gov/environment/biology/default.htm

Environmental Services Office (ESO), Region Environmental Manager, WSDOT.